Staff Paper

REBUILDING AFRICA'S SCIENTIFIC CAPACITY IN FOOD AND AGRICULTURE

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No Abstract

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CONTENTS

I. The Second-Generation Challenge

II. The Agricultural Knowledge Triangle

III. Agricultural Research and Extension: Capacity-Building Issues

IV. University Development: Expansion, Retrenchment, and Reform

V. The Second-Generation Challenge: Bread-and-Butter Issues

VI. Looking Ahead: The Need For a Strategic Paradigm

VII. Recommendations

Reference

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"The built-in incentives that characterize agricultural research in most low-income countries are bad. All too often, agricultural scientists are worse off than high-class clerks in the bureaucracy of the government"

-Nobel Laureate T.W. Schultz 1984

From 1987 to 1997, agricultural higher education received 2 percent and agricultural research and extension 98 percent of the World Bank's $4.8 billion of global investments in agricultural education, research, and extension.

A.Willett 1998

The vision of a new society in Africa will need to be developed in Africa, born out of the African historical experience and the sense of continuity of African history.

-J.F. Ade Ajayi, 1982

I. The Second-Generation Challenge

A decade ago, then-World Bank Vice President E.V.K. Jaycox identified the lack of administrative, managerial, and scientific capacity as the weak link in African development, and he urged the Bank and other donors to launch a number of capacity-building initiatives (1989). Jaycox was not the first to voice such concerns. Two decades earlier, the role of education as a contributor to capacity-building and national development was vividly laid out by Julius K. Nyerere in his paper "Education for Self-Reliance" (1967). Nyerere dissected the shortcomings of the colonial education system and called for a new model of "education for self-reliance and development." In the same year, Professor Thomas R. Odhiambo published his visionary article "East Africa: Science for Development" (1967), which called for coordination of national and regional science policies in East Africa and urged African governments to dramatically increase their investment in science education—starting in primary schools. These prescient insights remain largely unfulfilled, however. The past 40 years of debates about education and capacity-building have amounted to little more than empty promises and false starts; Africa's human-capital potential, which had been insidiously suppressed under the colonial system, is still suppressed.

To be sure, African countries have made great strides. Universities have increased in number, and student enrollment has risen at all levels. Nevertheless, universities throughout the continent are

facing severe financial problems, coupled with a decline in the quality of the educational experience and an exodus of senior academics to nongovernmental organizations (NGOs), the private sector, and attractive international positions (Lynam and Blackie 1994). But the brain drain, especially at the rank of professor and associate professor, [1] has been crippling African universities that are trying to build M.Sc. and Ph.D. programs. Senior scholars are needed to set the research direction and intellectual tone of their departments, and they are ultimately responsible for the mentoring of graduate students and the overall quality of their programs of study and research.

The first generation of African agriculturalists performed yeoman's service starting in the 1960s. They helped launch new universities and faculties of agriculture, and they tackled research—particularly on food crops and livestock for small holders—that had been neglected in colonial export-oriented research stations. In 1960, roughly 10 percent of the agricultural researchers in Africa were African, and the balance were expatriates. Thirty years later, those proportions had reversed—90 percent were African (Beintema et al. 1998). This was an impressive achievement, facilitated by a generous flow of scholarship money for overseas M.Sc. and Ph.D. training programs.

But at present the first generation of African agriculturalists has by and large retired, and the second generation of researchers and teachers is demoralized not only by poor conditions of service but the low rate of return of many young academic staff members on overseas training programs. Moreover, Africa's human capital is being ravaged by the HIV/AIDS pandemic. Without question, the second-generation crisis in the African scientific community is severe, it is not amenable to a quick fix, and it bodes ill for the future. African scholars and researchers, with their unacceptably low salaries and inflation-riddled retirement programs, outmoded scientific infrastructure, and thin operating budgets, are poorly prepared to train the third generation of agricultural scientists.

What can be done to rebuild and re-energize the second generation? One way is to introduce lower-cost degree programs through sandwich courses, distance education, and the increased use of information and communications technology (ICT). Another is to increase the number of scholarships for overseas study, especially at the Ph.D. level.

But overall, Africa's second generation challenge calls for an institution-building initiative comparable to the human-capital-improvement initiatives that were launched in Malaysia, Brazil,

[1] The loss of senior academics is dramatized at Egerton University in Kenya. In 1998, there were only six senior faculty (professors and associate professors) out of 135 members of the Faculty of

Thailand, Indonesia, and India in the early 1960s and steadfastly implemented for two decades (Lele and Goldsmith 1989).[2] Moreover, the severity of the situation requires a strategic national-regional-global effort, in place of the present country-by-country and project-by-project approach, to building a strong agricultural science base within Africa. Meanwhile, African governments and the donor community need to devote more attention to the political reforms that are a prerequisite for university reforms. A massive institution/capacity-building program must be grounded in the political fabric of Africa because, at the end of the day, the people who occupy the state house are of overarching importance in either building or destroying a modern scientific community. The success in Mali and Uganda and the painful events in Liberia and Zimbabwe speak to this point.

This background paper is organized as follows: Part I introduces the second-generation challenge. Part II lays out the basic issues and illustrates how the concept of an "agricultural knowledge triangle" helps us to examine investments in agricultural higher education, research, and extension. Part III reviews the problems facing national agricultural research and extension systems, which are the largest employer of agricultural graduates. Part IV addresses university development. Part V outlines some practical steps for meeting the second-generation challenge. Part VI discusses strategic issues involved in looking ahead, and Part VII presents a number of recommendations to the IAC Panel.

Agriculture's academic staff (Eicher, 1999, p.40).

[2]See Lele and Goldsmith (1989) for an analysis of India's development of human capital in agriculture. India sent about 1000 scientists overseas for M.Sc. and Ph.D. degrees in agriculture in the 1960s and 1970s, and the nation built 31 new state agricultural universities. (A few states have more than one university.)

II. The Agricultural Knowledge Triangle

Specialists in institution-building have recommended a "systems approach" for coordinating investments in three basic and interlinked agricultural areas: research, extension, and higher education. This approach has been variously called an "agricultural knowledge system" (Roling, 1988), "agricultural-knowledge information system" (AKIS) (FAO and the World Bank, 2000), and "agricultural knowledge triangle" (Eicher, 1999). These three key pillars of research, extension, and higher education, being complementary investments, should be systematically planned and sequenced—with communication, interaction, and cooperation between their practitioners—rather than treated as separate activities. And because they are risky at early stages of economic development and have long-term payoff, the government rather than the private sector is usually the main investor; government investments in research produce public goods such as new technology that generate spillovers and benefit more than one generation or socioeconomic group.

But instead of investing in the three pillars as an integrated system, most donors in Africa, daunted by its administrative difficulty within their present infrastructures, have pursued a pillar-by-pillar or project-by-project approach. "The agricultural divisions [at the World Bank] have no responsibility for universities, which are the responsibility of the education divisions," says a former extension specialist at the Bank. "It is not therefore surprising that the bank projects in extension and research do not provide support to higher agricultural education" (Venkatesan, 1991).

This piecemeal approach to institution-building has often created poorly sequenced, dysfunctional, oversized, and generally unsustainable agricultural institutions in Africa. In practice, the AKIS framework has been a toy rather than an operational tool, and most donor agencies are dubious about seriously financing agricultural-education projects. For example, the World Bank made only three such loans in sub-Saharan Africa from 1987 to 1997 (Willett 1998), even though the Bank prides itself on being a "knowledge organization."

One cause of this disparity is the lack of political savvy among potential recipients. The faculties of agriculture at most African universities tend to remain on the fringes of the subregional research organizations (ASARECA [Association for Strengthening Agricultural Research in Eastern and Central Africa], CORAF [Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles], and SACCAR [Southern African Centre for Cooperation in Agricultural Research and Training]). Nor do they hold annual meetings to display their members' research findings to the donor

community or their countries' ministries of agriculture, higher education, or finance. By contrast, the "agricultural research lobby" is skilled at courting and generating donor support. Without question, the creation of the CGIAR (Consultative Group on International Agricultural Research) system in the early 1970s, followed by ISNAR (International Service for National Agricultural Research), SPAAR (Special Program for Agriculture in Africa), SROs (subregional organizations), and FARA (Forum for Agricultural Research in Africa), represent a well-oiled machine that skillfully makes the case for investment in research (Eicher and Rukuni 2003).

What can universities do to emulate the agricultural research lobby? The World Bank's preparation of MAPP (Multi-Country Agricultural Productivity Program) for Africa presents a window of opportunity (World Bank 2003), with some US$1.7 billion earmarked for agricultural research and extension in Africa over the next five years. Although the MAPP concept paper does not presently include funds for strengthening agricultural higher education in Africa, NEPAD (New Partnership for Africa's Development) should perhaps be deployed to lobby the Bank for the purpose of including that function.

Sadly, national governments often have idiosyncratic priorities and actively resist real coordination as much as donors do. As a result, a comprehensive approach to building agricultural knowledge systems will not be forthcoming until African scientists, educators, and extension specialists seize the initiative and provide leadership in crafting country-specific agricultural knowledge systems (Rukuni, Blackie, and Eicher 1998). They must sell this integrated institution-building approach to the political leaders in their respective developing countries and then to donors. Finally, deans of agriculture need to become agricultural entrepreneurs and build political support both among farmers at home and foundations and other donors elsewhere in the nation, region, and world.

The ultimate goal of building a system of three interacting pillars rather than investing in one at a time is "connectivity" between the complementary institutions and a reward structure that encourages managers, scientists, and academicians to communicate and cooperate with each other (even when they individually report to different ministries). Such an effective agricultural knowledge triangle will increase agricultural productivity and—through lower food prices, food security, income generation, and employment—the welfare of all members of society (Bonnen 1998).

III. Agricultural Research and Extension: Capacity-Building Issues

Beliefs That Have Shaped the Design of Rural Institutions

It is important to acknowledge several flawed beliefs about development that were strongly held in the early 1960s and that continue to thwart institutional innovation and the growth of the private sector to this day. They help to explain why it has been so difficult to craft country-specific, interactive, and financially sustainable African agricultural institutions:

At independence, most African leaders believed that the state—not the private sector—should be the central planner, financier, entrepreneur, and risk-taker in generating jobs and "bringing development to the people." The highly centralized Training and Visit (T&V) extension model that was introduced in Africa in the late '70s was compatible with this prevailing view of the state's starring role in top-down development planning. However, this miscasting has diminished in many countries since the '80s because of a plethora of failed state farms, processing plants, and grain-storage facilities.

The second belief concerns the inexorability of time and the presumed talent of African nations to skip stages of development and speed up institution-building through large infusions of foreign aid. Back in the '60s, most African leaders articulated a vision of leapfrogging certain critical steps and becoming modern industrial nations in one generation. But capacity-building is an accretionary process that unfolds slowly and almost invisibly over a period of decades. EMBRAPA (the Brazilian Agricultural Research Corporation), which is the NARS (National Agricultural Research System) of Brazil, is now being lionized for its sterling research, but it should be kept in mind that Brazil has been independent for almost 200 years! The University of Bombay conferred its first Ph.D. in economics in the mid-1930s; while the University of Ibadan, the first university in Nigeria, was not established until 1948. Even under the most favorable conditions, Southern nations in general and African nations in particular cannot be expected to develop globally competitive human-capital capacity—say, in biotechnology—virtually overnight.

The third belief that accompanied independence was that one model of extension, food production, or university could be introduced, scaled up, and sustained throughout Africa. Various candidates have been introduced, including T&V extension, land-grant universities, and the Sasakawa Global 2000 (SG 2000) food-production model that was based on the success of the Green Revolution model in Asia (Eicher 1989). The land-grant model fizzled in the 1980s and the T&V extension model was

quietly abandoned in the late 1990s after the World Bank had aggressively promoted it in some 30 African countries.

The fourth belief is that developing countries should be encouraged to spend as much on agricultural research as industrialized countries. In the 1960s and '70s, for example, African governments were encouraged to spend one to two percent of their agricultural GDP on agricultural research—the same level as in the North. Fortunately, this simple guideline is no longer used in most donor circles because of the realization that money is not a substitute for time in building scientific capacity.

The fifth belief—another contributor to the preparation of large and unsustainable projects in Africa—is the uncritical use of high-rate-of-return estimates based on studies in industrialized and Asian countries. Such assessments provide little guidance on the future financial and scientific viability of an African NARS.

Agricultural Research: Insights and Challenges

The colonial and post-colonial research experiences shed light on some of the critical issues of organizing agricultural research:.[3]

Who Is in the State House?

The lack of political commitment in the state house is the biggest single obstacle today to building strong and productive NARS in Africa. To be sure, foreign aid can serve as a "handmaiden," but it is no substitute for political leadership, time, and learning by doing. Developing a science-based agriculture, in short, is an indigenously led and accretionary process. And it must begin at the country's political level, as occurred in China when the State Council issued a decree to pursue a new round of radical reforms for creating a modern, responsive, internationally competitive, and fiscally sustainable research system (Huang et al. 2003).

There is also a need for aggressive decompression of many countries' core agricultural services in order to improve their performance and raise participating scientists' salaries and benefits. The goal of such decompression is to develop an efficient and productive NARS that can be financed primarily from national resources. Meanwhile, donors have an important obligation to assist in this process by

providing bridging funds; excessive and erratic donor aid has been a major contributor to the current crises in many NARS in Africa. For example, the decompression process is now underway at the Kenya Agricultural Research Institute, with the assistance of the European Union and World Bank in collaboration with Kenya's Ministry of Finance. At the end of the day, downsizing should be viewed as part of a process of searching for a new NARS paradigm that features partnerships with NGOs, universities, and the private sector in the organization and provision of agricultural research, extension, and higher education.

Foreign Aid

A radical rethinking is urgently needed on how Africa can best organize itself to take advantage of the world's rapid scientific progress. Africa's scientific community clearly cannot flourish if it continues to be heavily dependent on erratic foreign aid for 40 percent or more of the budget of its NARS. The challenge is for NARS managers and scientists/entrepreneurs to develop retrenchment programs (in cooperation with ministries of finance and donors), spin off some commodity research programs to producer groups, generate additional revenue through producer levies, pursue contract research and alliances with the private sector and foundations, and generate revenue from the commercialization of NARS products and services (Echeveria and Elliott 2002).

Sustainability

At present, economists do not have a practical appraisal tool for determining what size NARS a borrower should aim for and what the indicators of success are for achieving long-term scientific and financial sustainability. There is a dearth of information on how to analyze the borrower's long-term capacity to sustain its NARS without donor support. Because the issue of sustainability is masked in the early years, when donors pay a large share of the project, many NARS have added hundreds of scientists without realizing that once the infrastructure is built the main cost of research will be salaries.

Building Biotechnology Capacity

Kenya, Zimbabwe, and South Africa boast strong national commitments to biotechnology research. And Ethiopia has prepared a 20-year biotechnology strategy, set up an agricultural technology research coordination office within EARQ (Ethiopian Agricultural Research Organization), and prepared a plan to develop an Agricultural Biotechnology Research Institute (Zeweldu 2001). But

[3] For a discussion of research in the colonial period see McKelvey 1965 and Eicher 1989; postcolonial period see Lynam and Blackie 1994. Also see Gora Beye (2002) for a comprehensive

other African nations are at an early stage of biotechnology research, even where one might have expected otherwise. For example, at independence in 1957 Ghana was one of the most economically advanced nations in Africa, yet today it does not have a coordinated national effort in biotechnology.

The biotechnology revolution is being driven by a wide range of highly specialized knowledge, both new and traditional. Also, the dividing line between agricultural and non-agricultural sciences is becoming blurred. As a result, agricultural researchers will need to draw on the traditional knowledge and breeding techniques of plant breeders, the work of scientists in faculties of agriculture, and additional new knowledge from such sources as molecular biologists, specialists in environment, law, commerce, and social science, and private biotechnology and multinational seed and fertilizer firms. A major challenge for all these players is in the pragmatic, day-to-day details. For example, the managers of NARS and deans of agriculture in Africa must figure out how their separately governed research and teaching institutions can best cooperate, beginning with the decision of where a biotechnology research center should be located—on a university campus or at a NARS?

Agricultural Extension: Searching for a New Paradigm

General Issues

Agricultural extension is vital to the diffusion of new technology. Yet extension is currently moribund in many African nations. Kenya has 12,000 extension agents but lacks operating funds to buy gasoline for its motorbikes. Zimbabwe recently merged its research and extension services, but inter-service rivalries (and impediments) remain.

The extension dilemma can only be understood in historical perspective: three models have dominated extension debates in Africa since independence. First the "quantitative model" was introduced in the 1960s by Western experts who assumed that new technology from temperate climates could be more rapidly transferred to Africa and diffused to farmers if the number of extension agents was dramatically increased. African governments collectively hired 36,000 new extension agents (increasing their number from 21,000 to 57,000) over the 1959 to 1980 period (Judd et al. 1986). However, this model collapsed because of poor management, a lack of new technology to extend, and problems of financing the expanded system.

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assessment of the impact of foreign aid on the development of NARS in Africa.

The second model of extension was the T&V (Training and Visit) model. This was a highly centralized mechanism—propagated by a former Director of Extension in Israel who helped the World Bank introduce it in Turkey in the late 1960s and later in India—that attempted to improve the management of national extension systems. The Bank introduced the T&V model in Africa in the '80s and helped extend it to some 30 African nations, with Kenya as the testing ground for measuring its performance. A recent Bank study concluded, however, that "the performance of the T&V system as applied in Kenya has been disappointing. The system as implemented has been ineffective, inefficient, and unsustainable" (Gautam, 1999). The rise and fall of T&V extension in Africa offers a sobering example of the failure of an imported model that was aggressively promoted in Africa without pilot projects, independent Africa-wide evaluations, or attention to its fiscal sustainability. Today, African agriculturists are more seasoned and less gullible; they would not accept the proposition that one extension model can serve the diverse needs of the continent's 48 countries.

A third extension model—the privatization model—is now being pilot-tested in Mozambique and is in the early stages of implementation throughout Uganda (Nahdy et al. 2002). Five factors are driving the intense interest in this model:

- Many of the national extension programs are starved for operating funds because of reduced Ministry of Agriculture budgets.
- After 10 to 20 years of experience with the T&V model, many extension experts realize that these donor-financed schemes were too large to be financed by African governments once the foreign aid was phased out.
- Private extension has been effective for export crops where farmers are taxed to finance both research and extension.
- Many village and church groups in Africa have already set up their own extension networks to fill the vacuum created by the collapse of the T&V model.
- Private extension is spreading in industrialized countries such as the Netherlands, New Zealand, and the United States.

Nevertheless, some tough questions need to be addressed in the current debate on the privatization of extension, especially in countries where the average per-capita GDP is one or two dollars a day. Under such circumstances, can farmers really be asked to contribute to the "care and feeding" of a private extension agent? Unless there are some examples of countries in which the poor have successfully bought their way out of poverty, donors should step in and offer grants to African

governments to help underwrite the start-up costs of private extension. After three years of debate over alternate extension models, Uganda's Parliament approved a National Agricultural Advisory Development Service (NAADS) Act in 2001, which established the institutional framework for the creation of a private extension model. This model will use pooled funding from the World Bank and other donors, which will flow to the nation's treasury and down to the districts, sub-counties, and farmers' organizations. They will then use the funds to negotiate contracts with former extension agents or NGOs to provide extension services to local farmers (World Bank 2001).

Extension Experiments in Mozambique

Many academics and donor specialists have endorsed the general prescription of a new extension paradigm that embraces decentralization, participation, outsourcing (contracting), and cost recovery with the goal of reducing both the size of the government bureaucracy and public outlays on extension. But despite its appeal, this should not become the specific prescription for any particular country in Africa. The challenge for each African government is to design its own models of extension, and this requires innovative leadership, pilot studies, and careful monitoring and evaluation with respect to local specifics.

Mozambique is playing a leading role in southern Africa by experimenting with its own extension models (Gemo, Eicher, and Teclemariam 2003). Although Mozambique became independent in 1975, public extension was not institutionalized as a separate directorate within the Ministry of Agriculture until 1987; and because of the civil war, this National Directorate of Rural Extension (DNER) did not become operational until peace was declared in 1992. DNER is a relatively lean and embryonic organization with a total of 639 public extension workers to serve three million small holders, and it is currently pursuing a learning-by-doing approach (Eicher 2002).

There are three types of extension providers in Mozambique: in addition to the public entity (DNER), there are NGOs (international and local) and private firms (especially for cotton and cashew), for a total of 1300 extensionists. The basic question for policymakers is how to build a Mozambican extension system that is not only pluralistic but fiscally sustainable in an environment where donors are influential (they are financing the bulk of the Ministry of Agriculture's budget) and yet there is a prevailing atmosphere of movement toward privatization, concurrent with the downsizing of public extension.

Several insights flow from Mozambique's attempts to craft its own models. The first is that international NGOs represent a proven way of delivering extension services in Mozambique. Some of this success is attributable to a generous flow of foreign aid, hiring the best local people, and working in circumscribed high-potential project areas. However, the international NGOs that depend on foreign aid for the bulk of their financing are unlikely to be financially sustainable as foreign aid dries up. One can make a case for donors to gradually shift their financial support from international NGOs to local NGOs.

The second insight is that global experience suggests it is more difficult for extension reforms to reduce the total public expenditure on extension than it is to develop a pluralistic system of extension providers. Even in Chile, a middle-income country, public expenditures on extension are still 85 to 90 percent of the total extension budget after 22 years of experimentation (Berdegue and Marchant 2002). Therefore Mozambique's Ministry of Agriculture should assume that even if an array of NGO and private extension-service providers emerge over time, the government will most likely be the main financier of extension for decades to come.

The third insight is that privatization is premature in many African countries, which often have limited market participation, weak institutions, poor roads, and modest private-sector involvement in input delivery and marketing.

IV. University Development: Expansion, Retrenchment, and Reform

It's a plain fact that poor countries cannot pay as much for education as rich countries can. Consequently, poor countries have to establish much clearer educational priorities, both in terms of quantity and quality; these decisions necessarily involve some hard choices, especially for higher education.

University development in Africa can be examined by dividing its recent history into three phases: a vigorous expansion phase in the 1960s and '70s, when universities performed brilliantly in increasing the output of undergraduates (Ajayi, Goma, and Johnson, 1996); a retrenchment phase in the '80s, and a renewal phase beginning in the early '90s.

University Expansion

Three strategies have been used to try to expand and strengthen agricultural education in Africa over the past four decades. The first was the introduction of the U.S. land-grant university model, with its triple mission of research, extension, and teaching. Several U.S. universities, with support from the USAID (U.S. Agency for International Development), helped set up a number of new universities in Africa that embodied some of the land-grant ideas. But the research and extension missions of the land-grant model were typically in conflict with the entrenched research and extension departments in Ministries of Agriculture. By the l980s, most of the new African land-grant universities were converted into all-purpose institutions with emphasis on undergraduate teaching (Johnson and Okigbo 1989, Hansen 1990 and Eicher 1999).

The failure of the land-grant model in Africa prompted delegations from Nigeria and Tanzania to visit India in the early '80s and study India's innovative state agricultural university (SAU) model, in which vice chancellors report to the Ministry of Agriculture rather than to the Ministry of Higher Education; in that way, the connectivity between research, extension, and agricultural higher education is increased. Nigeria subsequently set up three federal universities of agriculture based on the Indian model, but they all experienced difficulties (Idachaba 1999). For its part, Tanzania established the Sokoine University of Agriculture in 1984 by upgrading the Faculty of Agriculture at Morogoro into a higher-education institution with emphasis on agriculture, forestry, and veterinary medicine. Unfortunately, both the U.S. land-grant and the Indian state agricultural university models

have floundered in Africa, once again demonstrating that imported institutional models have a high failure rate.

The second large university experiment was the 20-year global University Development Program financed by the Rockefeller Foundation from 1963 until 1983. Three African universities—Nairobi (Kenya), Ibadan (Nigeria), and Kinshasa (Democratic Republic of Congo)—participated in this 12-country international effort aimed at helping universities become more effective in addressing some of the problems of development. However, the Foundation phased out the initiative early because of mixed results and unexpected political difficulties in a number of countries, including the Congo and Nigeria. Coleman and Court (1983) studied this experience and emphasized that to develop strong and sustainable postgraduate programs it typically takes a good deal of time, adequate infrastructure, a motivated and well-paid academic staff, and adequate indigenous financial support—little or none of which were available in these cases.

The third institutional innovation in agricultural higher education is a proposal to mobilize African academic staff with advanced degrees to carry out agricultural research of mutual interest to NARS and faculties of agriculture (Mickelsen et al 2003). The motivation for this initiative comes from the fact that universities often have more Ph.D.s in agriculture than does the government research system. Thus competitive-grant schemes are now in operation—in World Bank-financed projects in Malawi, Kenya, Ghana, and many other countries (Echeverria and Elliott 2002)—to increase the ability of university scholars to carry out research. However, these funding schemes are often oversold and they are difficult to administer in small countries. Also, there have been many problems in "the NARS/university relationship." Conflict and misunderstanding are common between the strong (NARS) and the weak (faculties of agriculture) (Castillo 1997). "At present," an African university professor recently observed, "academics and NARS staff view each other as competitors."

Retrenchment Phase

During the late 1980s and early '90s, numerous critics argued that African universities were bloated, inefficient, and in need of downsizing. They also maintained that students should be required to pay fees and that universities should become more entrepreneurial in mobilizing funds from the private sector (Saint 1992). The critics also pointed out that the annual cost of higher education per student was substantially higher in Africa than in Asia or Latin America, which led to intense policy debates on how to reduce this cost (Birdsall 1996). A study by World Bank economist Psacharopoulos

(1994), whose calculatations suggested that primary education in Africa generates a higher social rate of return to society than do secondary and higher education, was also cited. In the aftermath of these and other criticisms, African universities experienced a fall from grace, both at home and among donors (Saint 1992).

A retrenchment in donor support to agriculture and universities was especially severe. In 2002, the World Bank invested only eight percent of its total expenditures on agriculture, an all-time low. Donor funding was also curtailed for students studying agriculture in the North. For example, the total number of USAID postgraduate scholarships in the United States for students from developing countries in all fields of agriculture fell from 310 in 1990 to 82 in 2000 (BIFAD 2003).

Renewal Phase[4]

An unexpected renewal phase has been initiated by a half-dozen African universities over the past few years. University reforms have included innovations such as the admission of private fee-paying students, faculty retention of a share of their consulting income, the introduction of night classes and private universities, and the use of ICT both in university administration and in the classroom (Court 1999). These reforms did not take place in a vacuum, but were a product of larger political and social changes; Uganda and Kenya are prime examples of reforms that have become unblocked as a result of new leadership in the state house that is propelling the democratic transition (Lynam 2003). Meanwhile, many donors, such as the World Bank, appear to have have rediscovered universities over the past three or four years. For several decades the Bank gave priority to investments in primary education, but the Bank's new leadership in human resources has warmly embraced investments in higher education, as described in its book *Constructing Knowledge Societies: New Challenges.* (World Bank 2002). Finally, a new USAID global initiative has recently been introduced to increase the number of scholarships for postgraduate study in agriculture in the United States and the number of capacity-building grants to help rebuild universities' faculties of agriculture in developing countries (BIFAD 2003).

Four U.S. foundations have played a critical role in supporting the renewal phase of African higher education. In 2000, the Rockefeller, Ford, Carnegie, and MacArthur Foundations launched the 10-year Partnership for Higher Education in Africa. These foundations committed to spending $100 million over the first five years to support universities in Uganda, Tanzania, Mozambique, South

Africa, Ghana, and Nigeria that are pursuing reforms. Four lessons have already been derived from the first three years of the Partnership's experience:

- African self-initiated reforms. Many of the higher-education reforms are closely related to broader changes such as democratization, economic liberalization, decentralization of governance, and increased autonomy of (and experimentation with) public institutions.

- Time. The foundations report that it took about a year in each country for administrators and African scholars to develop business plans to reform their universities.

- Funding. The foundations spent $62 million in the first two years (2000 and 2001) in the six African countries. Graduate-training and capacity-building programs cannot be financed on a shoestring.

- Innovations in long-term training. Staff-development programs in the six Partnership universities are highly diverse. Some include traditional overseas Ph.D. programs while others have adopted the "sandwich" model, which enables young academic staff members to take their first year of graduate courses in their home universities, complete advanced coursework abroad (in the South or the North), and then return home to complete their thesis research. Still others are taking advantage of "virtual," or distance-education, degrees. And a few are experimenting with African-based graduate programs such as the African Economic Research Consortium's Ph.D. program in economics (Fine 1997).

[4] This section draws on BIFAD 2003.

V. The Second-Generation Challenge: Bread-and-Butter Issues

Building Africa-Based Graduate Programs

Overseas training and technical assistance are second-best solutions for meeting Africa's long-run human-resource needs in the agricultural sector. Technical assistance in particular is a useful stopgap measure, but unless it is coupled with the development of local training and research institutions, "a succession of expatriates learn more and more about developmental decision making while the Africans below them in the hierarchy become progressively more alienated and discontented. The experience and collective 'memory' which is accumulated during the process of development is thus appropriated by foreigners who subsequently leave the country, carrying these invaluable assets with them" (Helleiner, 1979).

Part of the problem has been the paucity of Africa-based graduate programs, coupled with a sharp reduction in the number of scholarships that would enable Africans to pursue graduate study overseas. When the African Economic Research Consortium carried out a study of graduate education in economics in Africa, it found that "graduate training in any meaningful sense appeared to have collapsed in most African universities" because of the "lack of funds, civil disorder, loss of good staff, deteriorating faculties and equipment, and a massive expansion of undergraduate enrollment" (Fine 1997). Meanwhile, many donors and foundations have "pulled the plug" on overseas training.

Special efforts must therefore be made to shore up the quality of M.Sc. and Ph.D. degree programs in Africa, and not only as a reaction to dwindling overseas opportunities. The fact is that even if donors paid the full cost of overseas training and it was of higher quality than local training, there would still be important advantages in emphasizing local graduate programs. First, the coursework in such programs is likely to better prepare students for careers in agricultural extension because the courses are grounded in national agricultural policies and local agro-ecologies, institutions, and farming systems. Second, the research of students in local graduate programs is more likely to focus on local and national problems than that of students in overseas universities, who often have no alternative but to pursue research on problems of industrialixed countries' agriculture. Third, the incremental buildup of the quality of local graduate programs serves as an insurance policy, should a donor discontinue offering scholarships for overseas study.

As mechanisms for Africa-based training are introduced or fortified, the debate over building regional centers of excellence vs. establishing regional specializations in graduate programs—a controversy

that has churned for decades—continues. On first blush, it seems that building new regional centers of excellence can help induce senior African professors to return from the diaspora. But building another layer of educational institutions can be risky, divisive, and expensive. Seasoned observers such as Canadian consultant Jeffrey Fine have made the case for donors to support self-initiated efforts to build "regional specializations" in existing universities, as opposed to their supporting regional centers of excellence. Examples of regional specializations include the newly launched Ph.D. Plant Breeding program at the University of Natal, the M.Sc. degree in Agricultural extension at Makerere University in Uganda, the M.Sc. in Natural Resource Management at the University of Pretoria, and the M.Sc. program in agricultural economics for East Africa at the University of Nairobi.

Regaining African Scientists from the North?

In response to the sharp cutback in long-term technical assistance from the North in the 1980s,[5] several South-South, short-term, technical-assistance programs—such as the United Nations Development Programme's TOKEN project (Transfer of Knowledge Through Expatriate Nationals)—have been established. Similarly, a number of African scientists have organized global networks to motivate African scientists living overseas to return to their home university for the purpose of teaching short courses and helping to raise funds.[6] Some observers argue for more ambitious programs. Buoyed by India's and China's successes in enticing nationals to return home *permanently* to pursue scientific and managerial careers, they have suggested that senior African agricultural professionals abroad might also be encouraged to return and help fill the human-capital gap. But can Africa really regain its scientists this way?

The answer, I believe, is yes, but only regarding *some* of its expatriate scientists—and mostly among the relatively junior. We must acknowledge, first of all, that there is a global market for advanced human capital and that financial incentives are key to the migration of talent.[7] I have observed over

[5] See Elliot Berg's study of the rise of long-term technical assistance in the 1960s and1970s, and its decline in the 1980s (Berg 1993).

[6] For example, Ethiopia has developed a global network (GNEST 2003) of Ethiopian scholars who are living in the diaspora. Likewise, Friends of Njala University College in Sierra Leone is a network of Africans and non-Africans who are working to assist the rebuilding of the scientific infrastructure at Njala.

[7] Carrington and Detregiache (1998) report that "with regard to Africa, the biggest migratory flows to the US are from Egypt, Ghana, and South Africa. For these countries, over 60 percent of the migrants have a tertiary degree."

the past 40 years of work in Africa that once African nations experience a major exodus of 10,000 or more scientists, managers, and teachers—following a civil war, coup d'état, or decades of economic stagnation (as in Ghana, Nigeria, Ethiopia, or Somalia)—it is very difficult to interest a substantial number of them into returning home, especially while their country of birth remains at a low-income status. To be sure, there are exceptions—India, a poor country, attracted some of its 40 million people in the diaspora to to its booming high-tech industry—but I have never seen the agricultural sector in a low-income county serve as a magnet to regain expatriate agricultural scientists.

I believe we should focus on creative ways of making agricultural science and agribusiness attractive enough to *young* African scientists to entice them to return home permanently, but we cannot expect senior academics and researchers to do likewise other than on a short-term basis. To secure these young scientists' interest, political and scientific leadership must develop an attractive package of monetary and non-monetary incentives such as start-up research grants and rapid career advancement. These kinds of components are key not only to luring back scientists from the diaspora but to preventing brain drain in the first place.

History provides a valuable perspective on the symbiotic relationship between postgraduate training and incentives, the brain drain, and capacity-building in developing countries. Successful institution-building experiences in Brazil, India, Malaysia, and Chile over the past 30 years reveals that young scientists on overseas graduate-training programs can be attracted to return home and pursue careers in the core agricultural institutions and private sector if they can benefit from research funding, attractive monetary and non-monetary incentives, and, importantly, a viable scientific infrastructure for effective and lasting academic partnership. Such infrastructure should include post-degree networking, mentoring, access to the global scientific literature, sabbatical leave, and participation in national and regional workshops on development policy, management, and research topics (BIFAD 2003).

An American soil scientist recently commented on his experience in trying to get his postgraduate students to return to Africa: "The critical issue is having a professionally rewarding environment as a means of attracting postgraduates to return to Africa and stay. There also needs to be assurances that the home country will indeed hire them. In many countries the work environment has improved greatly (the advent of email/Internet/computer data analysis gets over many of the problems of isolation and enables them to remain current and get something done in spite of institutional constraints) but still has a long ways to go. The successful graduate needs access to a postdoc/early-

career package of start-up money for lab equipment and support to attend international meetings/workshops."

Reforming the Incentive Structure for Scientists and Teachers: Country Studies

Malaysia: When Malaysia became independent in 1957, its per-capita income of US$350 was the same as Ghana's. Since then, Malaysia has diversified from its historic emphasis on rubber research to include oil palm and food crops, and has increased the number of agricultural researchers from 100 to 1000. In 1988, research officers had access to low-interest loans to purchase a house or a car, a gift of a free airplane ticket to Mecca, and, as a capstone for working as a scientist until the retirement age of 55, a free around-the-world air ticket. Today, Malaysia has a strong public and private research system, which has been mainly financed by the government because the country has always been reluctant to accept foreign aid.

China: A decade ago, a typical noodle seller outside the entrance to a Chinese agricultural research station was earning more than a Ph.D. scientist inside. But with China's rapid rate of economic growth of (8 percent per year) in the 1990s and a change in science policy, the country created an economic base for attracting and rewarding good scientists, both from overseas and within China. The country's Academy of Agricultural Sciences has adopted a salary scale that is midway between Chinese local salaries and U.S. salaries—and similarly for benefits. In the late '90s, China placed a fraction of its 80,000 agricultural scientists into a category called the "innovation base"—including, that is, the most talented among them—and raised their salaries and benefits some 500 percent. More generally, new staff members receive a housing allowance, and researchers are allowed to accept domestic/international consulting assignments for two to three months per year (Huang, Hu, and Rozelle 2003). China now has a formidable scientific research base.

Mozambique: Currently, there are several dozen international NGOs in Mozambique with considerable scope and independence, and their staff's salaries and benefits are roughly double those of comparable posts in the Ministry of Agriculture (Eicher 2002). This intentionally wide salary gap has been responsible for a constant migration of government talent to the NGOs. The Ministry of Agriculture still has about 7,200 employees at present but is implementing a decision to reduce that number by about 1500, largely through early retirements. Red tape and bureaucratic hurdles has slowed the pace, but a US$750 one-time bonus is being given to encourage them to speed targeted staff's withdrawal from the system. The total cost, $650,000, is being paid for by pooled funding

from about a dozen donors. Phase II, underwritten by similar sources and costing $4 million, consists of offering an early-retirement package to 900 workers who will be eligible in the near future. The Mozambican experience illustrates how the government and donors are working together to reduce the size of the Ministry, while raising the salaries and benefits of those remaining.

Brazil: Brazil has a long history of public-research programs for farmers; its first was initiated about 150 years ago (Ruttan, 1982). In 1972, the nation set up EMBRAPA (the Brazilian Agricultural Research Corporation) to coordinate its national research program—including a human-capital improvement program, which has become one of the most impressive in the developing world. EMBRAPA was aided by a set of USAID-financed collaborative agreements, established in 1963 between four Brazilian and four U.S. counterpart universities, to fortify undergraduate agricultural higher education in Brazil. After a decade of success, the contracts were extended another four years to strengthen postgraduate education. During that period and beyond, EMBRAPA spent about 20 percent of its total budget on various training programs in Brazil and abroad; today it is an outward-looking entity with over 1,500 alliances with local, regional, and international organizations. In particular, EMBRAPA and Brazil's state universities and private sector are deeply involved in developing new technology to support the expansion of agricultural exports (mainly coffee, soybeans, and sugar) and value-added activities such as the cultivation of gourmet coffee for overseas consumers. In 2001, the average salary for a senior scientist at EMBRAPA's Tropical Cassava and Fruit Research Station was between US$14,500 and US$35,000 per year (Macedo etc 2002). In Ghana, by contrast, the director of the government's Cassava Research Program recently reported that the salaries for his researchers were "too low to quote" (Otto 2000).

Reducing the Cost of Postgraduate Education[8]

Many donors have criticized overseas graduate training for African students because of its rising cost and low returnee rate. (Table 1 displays the total cost of M.Sc. and Ph.D. degrees in various universities around the world.) Further, they have called for African-led initiatives to experiment with new models of postgraduate training that will not only be lower-cost and more retentive of graduates but also allow developing countries to build sustainable linkages to overseas universities.

[8] This section draws on BIFAD 2003.

Table 1. Costs of Graduate Degrees in Agriculture in Various Countries

Degree	Years	University/Country	Estimated Total Cost	Year
			$US	
M.Sc.	2	U.S.	56,000	2003 (incl. out-of-state tuition)
M.Sc.	2	Australia	32,000	1998
M.Sc.	2	Southern Africa	31,000	1998*
M.Sc.	2.5	Makerere, Uganda	25,000	1998
M.Sc.	2	UPLB, Philippines	24,000	1998
M.Sc.	2	U Malawi	18,000	1997
Ph.D.	3	U.S. universities	90,000	2003 (incl. out-of-state tuition)
Ph.D.	3	Asian Inst of Technology (Thailand)	40,000	2003**
Ph.D.	3	University of Agriculture Bangalore (India)	23,000	2003**
Ph.D.	3	University of Natal (South Africa)	55,000	2003
Ph.D.	4	Belgium ***	35,000	2003

***** Average total cost in four specializations (agronomy, animal science, land and water management, and agricultural economics) in four universities in Southern Africa (Anandajayasekeram et al 1996)

**Suvedi (2003)

***Tollens (2003). Four-year sandwich/fellowship program. The student spends one-third of his or her time in Belgium and two-thirds overseas.

For example, the sandwich model has been pioneered by a number of universities in Europe as a means of lowering cost and increasing the returnee rate. A Ph.D. student takes a first year of postgraduate course at his or her home university and then goes overseas for 12 to 18 months of further coursework. The student then returns to the home university to do research and complete his or her thesis. Sandwich programs are increasing in popularity because of their reduced cost, increased international interactions, and advantages to the students' home university and country.

In addition to cost-cutting sandwich models, there are other innovations for reducing the cost of postgraduate training. These include increased use of distance education and ICT (see below), summer institutes, and students' "human-capital chains" via the Internet for keeping in touch with their thesis supervisors and maintaining ready access to the global scientific literature.

ICT, Distance Education, and AGORA

The four U.S. foundations (Rockefeller, Ford, Carnegie, and MacArthur) supporting the renewal of universities in six African countries (Uganda, Tanzania, Mozambique, South Africa, Ghana, and Nigeria) are including highly targeted information and communications Technology (ICT) programs that range from registration and financial management to library and research applications. Without question, there is significant potential for Web-based distance education, and a number of U.S. universities have already been offering courses and even degrees over the Internet. However, this is not yet a proven mechanism for granting degrees in most African countries (Till 2003).[9] While the World Bank-financed African Virtual University (AVU), which was established in 1997 to provide students in Africa with access to quality higher education in science and engineering, has offered courses it does not yet offer full degree programs. Another such effort is the program created by the Institute for Food Laws and Regulations at Michigan State University, which consists of six distance-education courses that are noted for their cost-effectiveness ($794 per course). Similalry, USAID's DOT-COM Alliance and the investments of other donors will add substantially to the ICT infrastructure of developing countries. As this infrastructure grows, there will be more opportunities in Africa to test the benefits of providing local education electronically.

Regarding access to the global scientific literature, a pioneering Rockefeller Foundation-financed project, The Essential Electronic Agricultural Library (TEEAL), has provided access to 140 journals on CD-ROM to 72 libraries in the developing world (42 of which are in Africa). TEEAL has been implemented over the past six years by Cornell University's Albert R. Mann Library with great success. In September 2003, the U.N. Food and Agriculture Organization will join forces with

[9] Till (2003) summarizes his recent review of ICT in Africa as follows: "There has come to be a simplistic but widely held notion that ICTs will automatically benefit African education. The reality, however, is that ICTs can't go it alone: quality assurance, provided by adequate human resource infrastructure, is an essential part of the equation. Regrettably, such infrastructure is presently inadequate to meet the demand for post-secondary entry to higher education across the region in most of Africa."

Cornell and begin moving TEEAL to the Internet under the name AGORA (Access to Global Research in Agriculture). In this exciting development, the FAO has promised to provide global leadership for the AGORA project, which will offer free Internet access for scientists in developing countries.

Improving Thesis Supervision

African students pursuing M.Sc.'s in African universities often report that it takes them four to five years to complete a nominally two-year degree. The reason for such delays is the difficulty in finding a thesis supervisor who will mentor, nurture, and read draft manuscripts on schedule. A former professor at the University of Nairobi drew on his experience to suggest how to improve the situation: "There are many examples of joint thesis supervision and lecturing by NARS staff members, but it is through individual contacts and friendships," he said. "This arrangement is unsustainable and needs to be institutionalized." Contributions of NARS staff should "be formally recognized both by university and NARS, and be rewarded accordingly," he added. "This should not only include monetary rewards but also be considerations in the promotion of the staff concerned. Again, this calls for a national research policy that spells out clearly the working relationships between NARS and universities."

Kenya: Case Study of Regional Training Programs

One of the colonial institutions that has great staying power in Africa is the regional model of organizing agricultural research, networks, and university education. For example, regional training efforts are frequently mentioned as a way to drive down the unit cost of graduate programs. But the experience of the University of Nairobi illustrates the gap between theory and practice. With financial assistance from the government of Germany, the university launched in 1974 an M.Sc. program in agricultural economics for students from East Africa (Thimm 1992). The two-year program consisted of coursework during the first year and thesis research in the student's home country during the second year. The program flourished during the '70s but subsequently lost considerable steam; because of low salaries, funding constraints, and frequent university closures between 1985 and 1995, the Nairobi's Department of Agricultural Economics lost eight staff members with Ph.D.s. And finally, given a lack of scholarships, the intake of students from East Africa all but dried up in the '90s, falling to three (all Kenyan) in 1997. This sobering case study of a 25-year effort (1974-1999) to build and sustain an M.Sc. degree program reveals that while it was relatively easy to garner foreign

aid to launch a regional M.Sc. program it was difficult to gain local political and financial support to *sustain* that program decade after decade (Oniangi'o and Eicher 1998).

Universities: Synthesis

1. An indigenous and cost-effective human-capital renewal system is central to the long-run sustainability of African universities, research, and extension. Because of the cutback in foreign aid for overseas training, it follows that African universities are the only feasible institutions for training nationals in agriculture, science, and related fields.

2. The failure of policy reforms to speed economic recovery in Africa has created a growing awareness that efficient, reliable, and relevant institutions matter as much as policies for directly accelerating economic growth. Because African universities constitute a key element of the "agricultural knowledge triangle," it is important to nurture and enhance them to assure their meaningful contribution to national development.

3. There is growing empirical support for the proposition that the accretionary and virtually invisible process of "learning by doing' is an efficient way to build scientific and managerial capacity (Eicher 1989, 1990).

4. Many universities in Africa have more agricultural scientists with M.Sc. and Ph.D. degrees than are employed by the government. In 1995 in Eastern and Southern Africa, there were 547 African scientists with a Ph.D. in agriculture employed by universities and 357 in the NARS (Mrema 1997).

5. The academic staff and postgraduate students of African universities are valuable and cost-effective sources of agricultural innovation and achievement. Their work is complemented by contributions of scientists in the NARS, who often assist African universities by teaching postgraduate courses, mentoring, and serving as thesis co-advisors.

VI. Looking Ahead: The Need For a Strategic Paradigm

Over the past four decades the "agricultural research lobby" has used a tactical paradigm, which emphasizes high returns to investment in research, rather than a *strategic* paradigm that would stress

the payoff of investments not only in research but concurrently in extension and agricultural higher education. The narrow focus on research alone is an unfortunate carry-over from the colonial model of emphasizing research on export food crops and failing to build universities to train future African scientists.

Today, the World Bank's agricultural-knowledge information system (AKIS) does emphasize the three pillars of research, extension, and agricultural higher education. But although AKIS is featured prominently on the Bank's Website, it is not in MAPP—the Multi-Country Agricultural Productivity Program for Africa—that the Bank designed in cooperation with SPAAR, FARA, and the SROs to strengthen research and empower farmers, extension services, and agricultural advisory resources. MAPP is actually using a technocratic approach to strengthen only two of the pillars—research and extension. The bottom line, therefore, is that the MAPP proposal represents an incomplete and unsustainable model of technology generation and agricultural-productivity growth because consideration is not given to African universities and human-capital replenishment.

The IAC Panel should urge the World Bank to replace the MAPP's tactical paradigm with a systems approach. But the Panel will also have to convince the agricultural research lobby to include African universities in the MAPP action plan, both in substantive and financial terms.
As an aid to doing so, we propose five innovations:

- In a small country, invest in a single faculty of agriculture to meet the training needs of the national market.

- In some small countries, invest in a single faculty that is serving as a supplier of talent both to national and regional markets. For example, 25 percent of the students enrolled in the faculty of agriculture at the University of Mali are from nearby West African francophone countries. The improvement of the scientific infrastructure of the University of Mali represents a cost-effective way to train undergraduate students in agriculture from the entire region.

- Offer competitive capacity-building grants to strengthen already-established M.Sc. programs in selected universities.

- Reinforce Ph.D. programs in a few universities by helping to finance sandwich projects such as those at the Universities of Natal, Makerere, and Pretoria and at several institutions in the North.

- Set up a "fast track" disbursement system to assist in the recovery of universities in post-conflict countries such as the Sudan, Sierra Leone, and Angola.

We also propose that donors finance a series of summer institutes, which would be held in several locations in Africa and taught by visiting professors from around the world, in order to tap the global knowledge base. These institutes would provide an opportunity for visiting African and non-African scientists to interact with local colleagues, develop new professional partnerships, and stay abreast of the changing research problems in Africa.

Because of the decline in the quality of M.Sc. degree training programs in many agricultural disciplines in African universities, there is a particular need for donors to make strategic investments in strengthening these programs. For example, over the past two years a committee representing 16 agricultural-economics departments in 12 countries in eastern, central, and southern Africa has developed a proposal to offer a high-quality masters' degree in agricultural and applied economics in Africa beginning in late 2004 or early 2005 (Oluoch-Kosura and Fine 2003). This African-led initiative should be carefully considered by donors because of the strong demand for well-trained agricultural economists, especially in the private sector.

VII. Recommendations

1. Strategic Paradigm. The IAC Panel should urge the World Bank, NEPAD, and FARA to adopt a strategic paradigm for building a strong agricultural science base in Africa. They should invest, that is, in each of the three pillars of the agricultural knowledge triangle.

2. The Second-Generation Challenge. I have argued that it will be extremely difficult to entice prominent African scientists from the diaspora to return home permanently as long as the agricultural sector is moribund there and civil strife is pervasive. But instead of trying to regain senior African scientists from abroad, policy attention should focus on improving the scientific infrastructure and increasing the financial incentives to encourage *young* African researchers and teachers to return home—or to remain in Africa in the first place. Meanwhile,

special efforts should be made to interest overseas African scientists, both junior and senior, in returning to their home countries for short periods to mentor young scientists and teachers.

3. Political Reforms. Because universities are the product of a larger political and social milieu, it follows that political reforms are essential to clearing the way for academic reforms. In Kenya, for example, the sharp increase in the number of public universities and faculties of agriculture over the past two decades could not have occurred until the recent democratic transition took place. Moreover, Kenya as well as Uganda have shown how political reforms unleash the entrepreneurial energy of the university community. But in my opinion, only about a third of the 48 countries in Africa currently have the political leadership, stability, and interest to pursue the political reforms necessary for rebuilding universities and faculties of agriculture.

4. The Land-Grant Model, with its tripartite mission, has been unsuccessful in Africa for many reasons, including its inability to build a political power base among farmers and break the colonial mold of entrusting the Ministry of Agriculture to carry out agricultural research and extension. Land-grant-type universities were successful in doing research and extension during a honeymoon period, while donor funds were available, but once this aid was gone the universities slowly turned into all-purpose teaching institutions.

5. Cost and Quality. There are numerous innovations (such as distance learning, ICT, and sandwich programs) to reduce the cost and enhance the quality of M.Sc. and Ph.D. training and increase the percentage of overseas graduate students who return home.

6. The Regional Imperative. Because many countries in Africa are small, it has been difficult for local universities to achieve a critical mass of teachers in areas such as biotechnology, international trade, food science, and agribusiness. We should recognize, then, that it would be unwise for tiny countries such as Eritrea, Togo, Benin, and the Gambia to try to train their B.Sc. students in these fields locally. Rather, they should send them to other countries in Africa for such training. For example, Eritrea is currently sending hundreds of undergraduates to South African universities. In general, I believe it's necessary to turn to regional agricultural training models—which may be visualized as an ever-expanding pattern of concentric circles ranging from local to continental—for university degree programs that qualify students for public, private, and NGO employment in African agriculture.

Level I. Small Country. Typically there is one faculty of agriculture, with a curriculum focused on agronomy, plant science, livestock, and agribusiness, that trains students to work for the local government, NGOs, and private markets. The Faculty of Agriculture at the University of Botswana is a prototype institution of this type, and it produces high-quality graduates for Botswana. This model could be adapted in some other small African countries. One bilateral donor should be mobilized to assist the faculty for 15 to 20 years by investing in ICT, improving access to the global scientific literature, and encouraging participation in regional and global human-capital chains. (Although the Faculty of Agriculture in Botswana is currently funded by the government, in other small countries a single bilateral donor could be found to support a similar faculty.)

Level II. Small country with regional training capacity. The Faculty of Agriculture at the University of Mali is a prototype Level II institution because it currently offers a five-year undergraduate degree and has 600 students enrolled, 150 (25 percent) of whom are from 11 other francophone countries. This faculty needs donor support for foreign-student fellowships and for providing salaries to visiting scholars and Malians on sabbatical leave. It also needs funds for modest capital improvements such as drilling a well on its teaching farm, installing a dedicated phone line for the Internet, and establishing library connection to AGORA. One donor is needed for each Level II country.

Level III. Medium-Sized Countries. These include Senegal, Ghana, Zimbabwe, and Uganda, where there are two or more faculties of agriculture and several M.Sc.-degree programs. Donor support is needed to improve the scientific infrastructure and shore up the quality of the graduate programs.

Level IV. Large countries with Ph.D. capacity. South Africa, Ethiopia, and Nigeria are examples of countries with numerous masters' degree programs and some Ph.D. programs serving national and pan-African markets. Universities in these countries are typically understaffed with regard to senior academics, and their needs for support include ICT, library, and sabbatical-leave compensation. Several donors may be needed for each country.

Level V. Regional Centers of M.Sc. and Ph.D. Specialization. New regional degree programs include the proposed master's degree specialization in agricultural economics that will train students in their home university for one year and a regional location for the second year. Twelve countries in eastern, central, and southern Africa, representing 16 departments of agricultural economics, have designed this program. Other regional programs include summer institutes and support to expand the innovative Forum for Agricultural Resource Husbandry—which strengthens the M.Sc.-thesis research of students in eastern and southern Africa—to other parts of the continent.

Level VI. Post-Conflict Countries. Special attention should be given to rehabilitating universities in war-torn countries such as the Sudan, Angola, and Sierra Leone.

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